
# Electric Vehicle Supply Equipment
## Basics Review

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# What's What? Understanding Terminology

**Hybrid Electric Vehicle**

**Plug-in Hybrid Electric Vehicle**

**Electric Vehicle**

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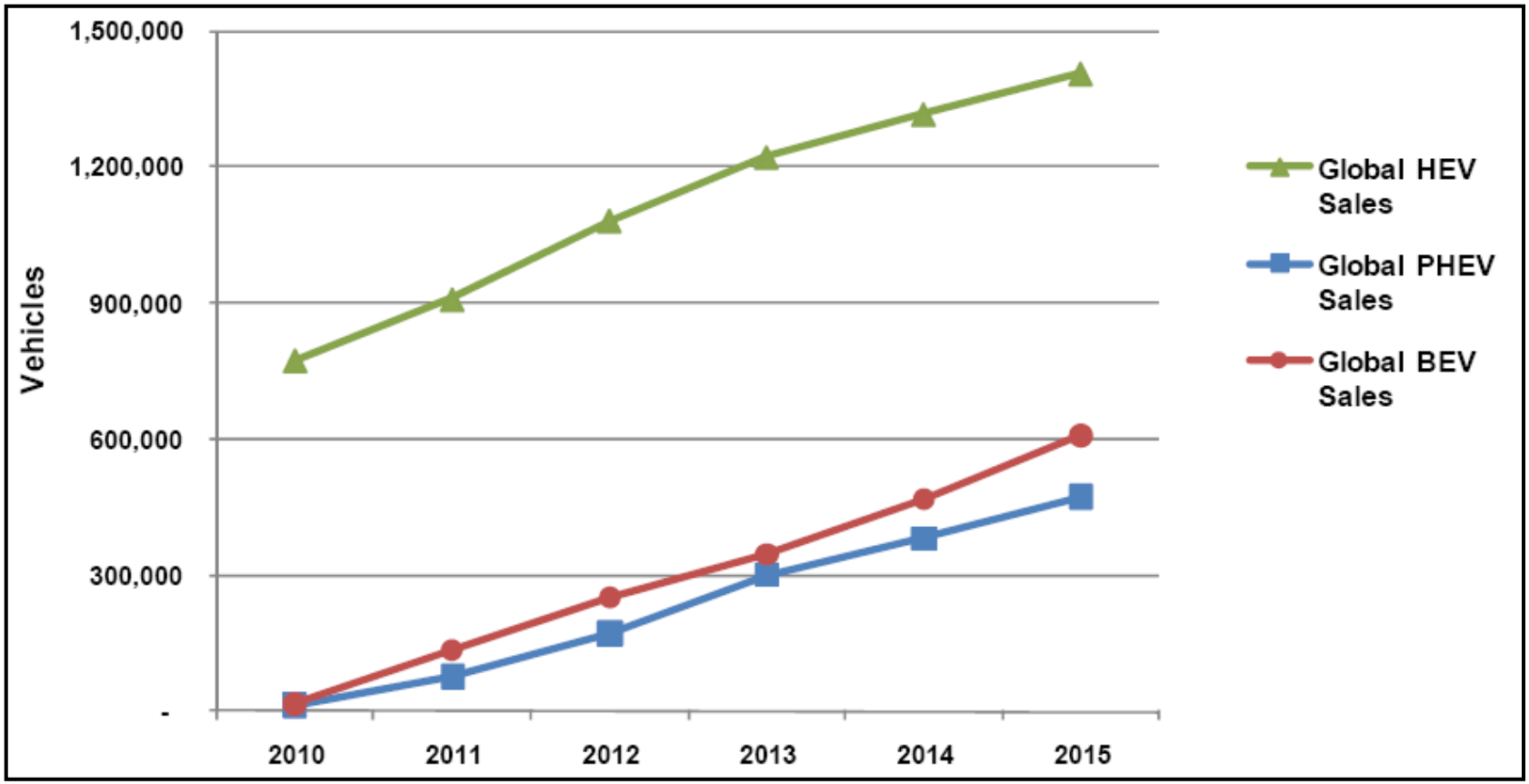
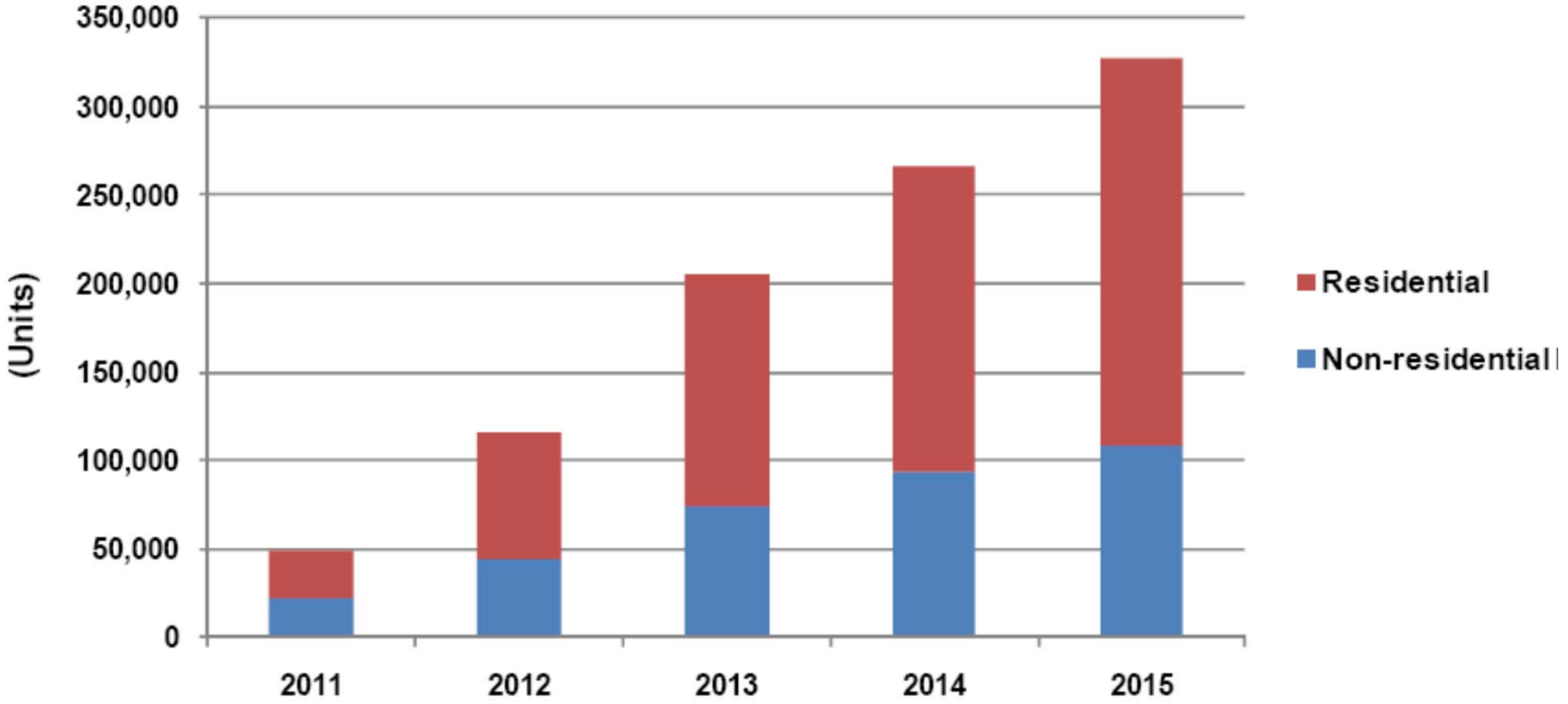
# Here come the EV's…..


# Total Electrified Vehicle Sales, World Markets: 2010 - 2015




*Source: Pike Research, Published 3Q 2010*

# Annual EV Charging Equipment Sales, United States: 2011-2015




*Source: Pike Research, Published 3Q 2010*

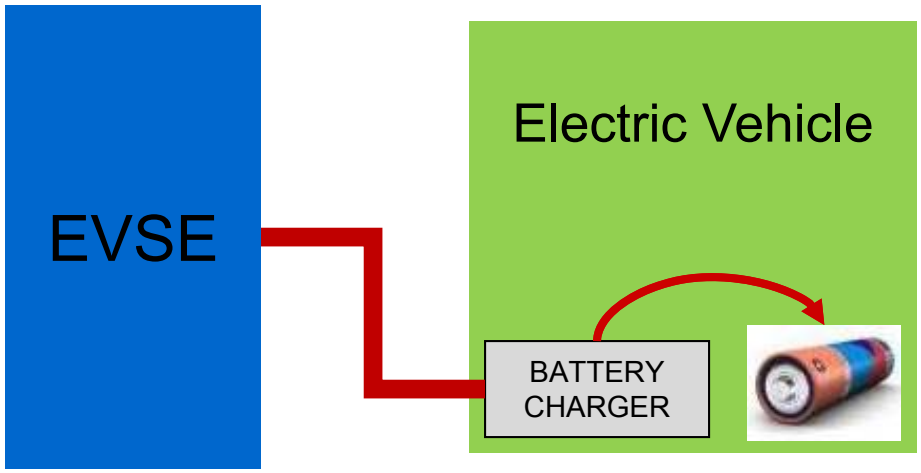
# Government Support

- Federal Government
  - Tax credits
    - EV or Plug-in Hybrid (with minimum 4kWH batteries) up to $7,500
    - Alternative Fuel Vehicle Refueling Property
      - 30% up to $30,000 for businesses
      - 30% up to $1,000 for residences
- Check your local and state government incentives.  Many were set to end in 2011

# Electric Vehicle Supply Equipment (EVSE)

- EVSE
  - Electric Vehicle Supply Equipment
  - General term used for all of the equipment used to supply electricity to the car
  - In most cases, the battery charger resides in the vehicle.  EV Supply Equipment is simply regulating the flow of AC power to vehicle charger
  - Only in DC charging is the EVSE equipment directly charging the batteries

# How does EVSE work?

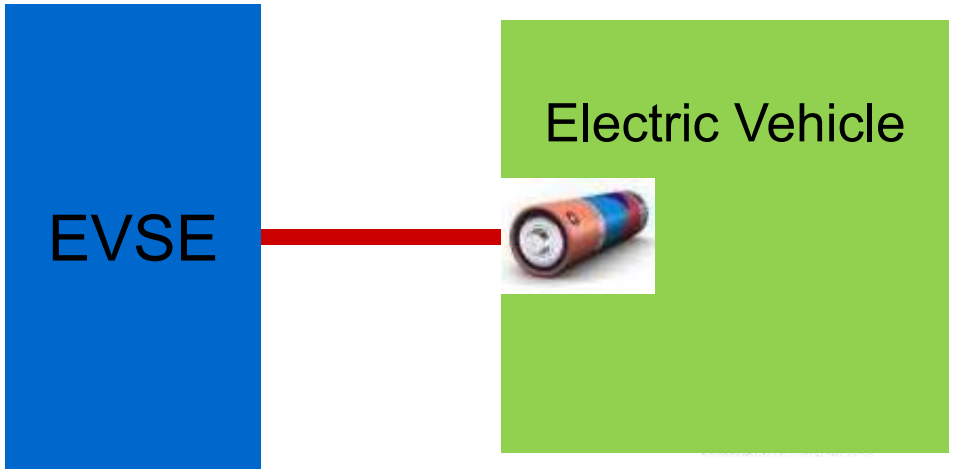



## AC Charging

Powers the car's onboard battery charger

## DC Charging

Direct charge to the car's battery

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# Level Terminology – NEC 2011

- **Article 625 – Electric Vehicle Charging System**
  - **Level 1**
    - 120Vac, 12-16A (up to 2 kW)
    - 15amp or 20amp receptacle
  - **Level 2**
    - 208 or 240Vac, 30-80A (up to 20 kW)
  - **Level 3**
    - DC (undefined)
    - Power requirements specified by equipment manufacturer

# Level Terminology – Society of Automotive Engineers (SAE)

- **AC Level 1 – 120V**
  - Single Phase 2kW
- **AC Level 2 – 240V**
  - Single Phase ~20kW
- AC Level 3 – Undefined
  - Single or 3 Phase
- DC Level 1 – 200-450V
  - ≤ 20kW
- **DC Level 2 – 200-450V**
  - ~80kW
- DC Level 3 – 200-450V
  - ~120kW

# EVSE Overview

## Eaton **Pow-R-Station**™ EVSE Family

### Level 1 AC

16amp Receptacle

12 - 18 Hours

### Level 1&2 AC

16 & 30amp

4 - 8 Hours

### Level 2 AC

30-75amp


4 - 8 Hours

### DC Quick Charger

(Level 2)


20 - 30 Minutes

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# Codes and Standards

- **UL 2594, UL 2231-1, UL2231-2, UL 1998**
- **NFPA NEC Article 625 –** Electric Vehicle Charging System
  - Defines the Electrical Code and Requirements around the installation of Electric Vehicle Supply Equipment
  - Considered “continuous loads”
- **SAE J1772™ –** Conductive Charging Connector
  - Society of Automotive Engineers J1772 Standards defines the physical medium by which the connection between the EVSE and vehicle is established
  - Defines the details of how the vehicle and EVSE interact during a charging sequence
- **SAE J2836 / J2847 / J2931 –**Electric Vehicle Communication
  - Defines communication and messaging between the vehicle and EVSE
  - Theses standards are in the beginning phases of being drafted
- **CHAdeMO**
  - Association formed by The Tokyo Electric Power Company, Nissan, Mitsubishi and Fuji Heavy Industries; later joined by Toyota using a standard connector for DC quick charging

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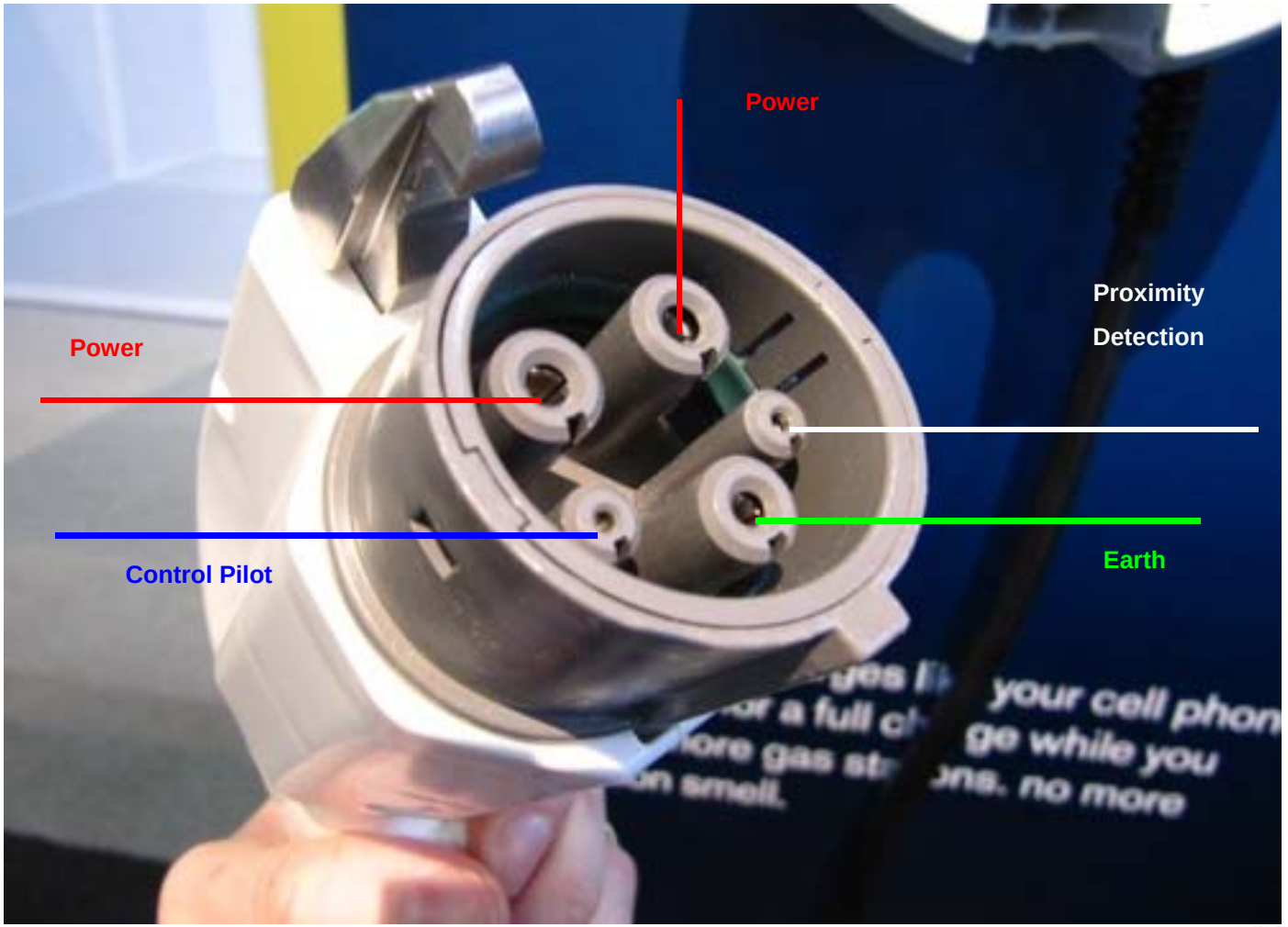
# Lithium-Ion Battery Basics

- **They are lighter. Typical lithium-ion battery can store 150 watt-hours of electricity in 1 kilogram of battery. (6 times as much as Lead Acid and 2x as much as Nickel-metal Hydride (NiMH)**
- **They hold their charge. A lithium-ion battery pack loses only about 5 percent of its charge per month, compared to a 20 percent loss per month for NiMH batteries.**
- **They have no memory effect, which means that you do not have to completely discharge them before recharging, as with some other battery chemistries**
- **Lithium-ion batteries can handle hundreds of charge/discharge**

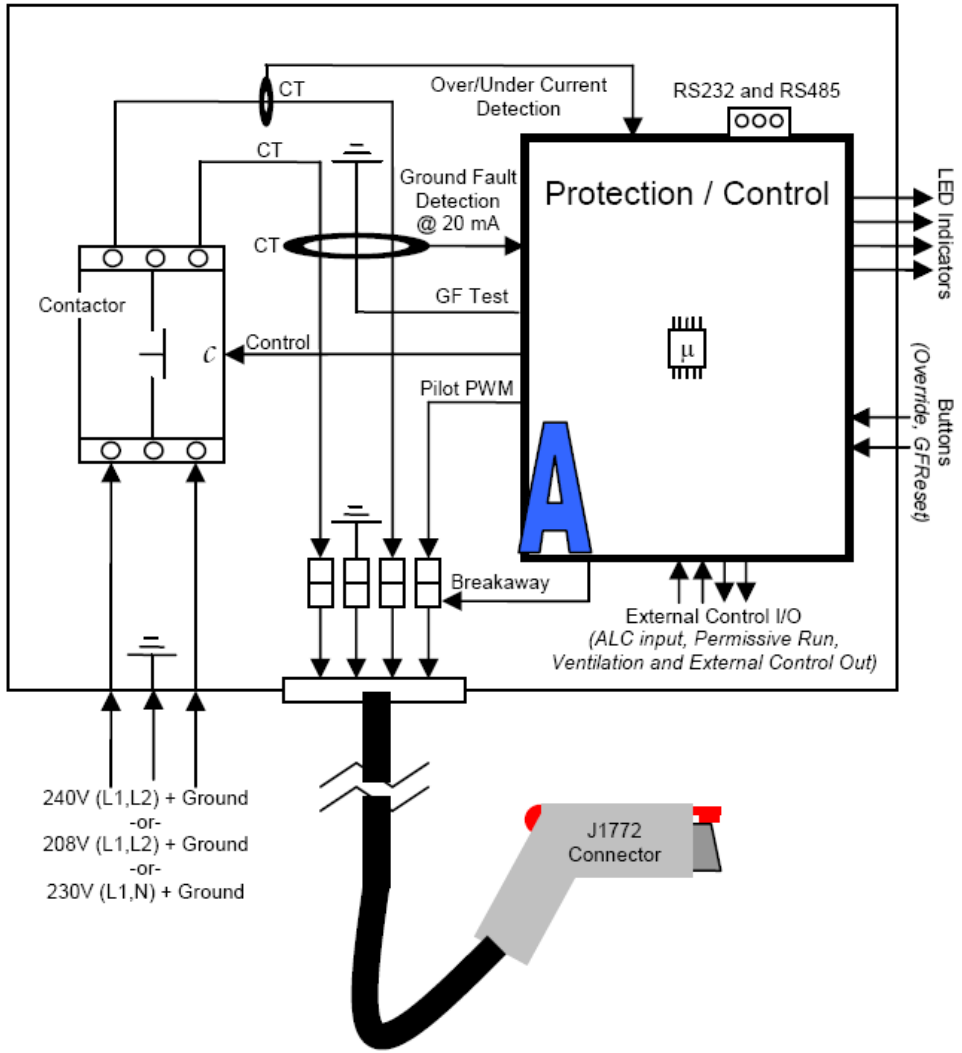
# SAE J1772™ Connector



# SAE J1772 Handshake – High Level - How Does It Work?

- Step 1: Driver plugs J1772™ connector into the inlet located on EV
- Step 2: EVSE confirms that it is a car by waking it up through one of the pins in the connector
  - Note: Five pins on the connector have no AC power to them at this point - safe to touch
- Step 3: EV tests to make sure it is connected to an EVSE, and then tells the EVSE whether the battery needs ventilation
  - Note: Ventilation in most cases is not necessary
- Step 4: EVSE responds by telling the EV the EVSE's available line current (ALC)
  - Note: Maximum current that the EV is allowed to draw
- Step 5: EV's onboard battery charger uses this information to compare to its own maximum current to find the lesser of the two
- Step 6: Power is turned on by the EVSE to the connector

# AC Level 2 EVSE Overview




- Protection and Control Board
  - Handles hand-shaking with the EV
  - Monitors, stops/starts flow of electricity
  - Protects from over/under current, ground fault, breakaway, etc
  - SAE J1772 Compliant
- Electrically operated Contactor sends power to the EV

# AC Level 2


**Wall-Mount**


**Pedestal**

# Understanding the User Interface

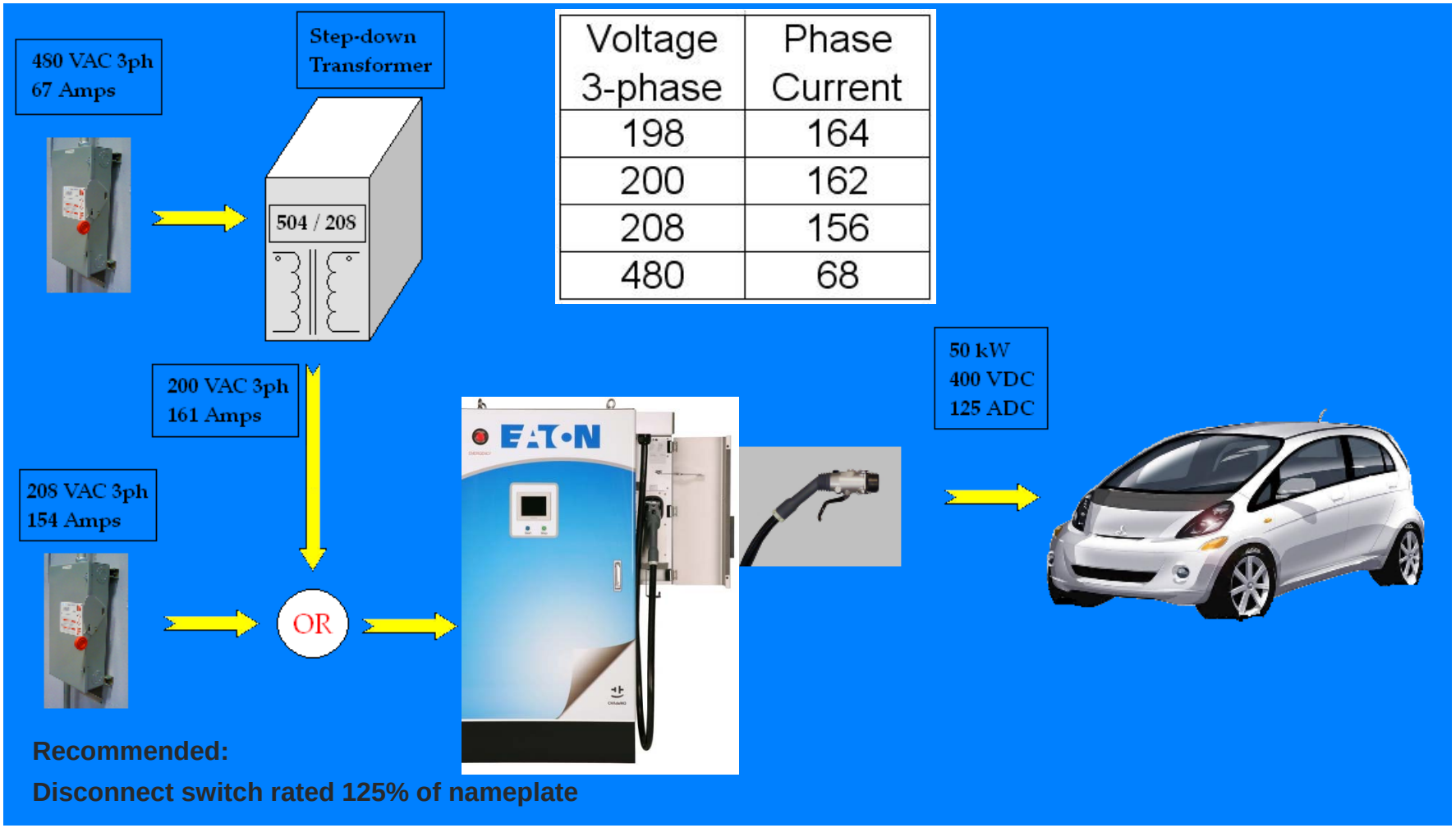
| | Blink | Steady |
|---|---|---|
|  | Payment / Authorization Needed | Unit Ready for Charge Session |
|  | Vehicle Connected, EVSE Ready, Waiting on Vehicle | Vehicle Charging |
|  | N/A | Vehicle Has Ended Charge (May begin again at anytime) |
|  | Rate of Charge Contolled Remotely and Charging Set to INACTIVE | Rate of Charge Controlled Remotely and Charging ACTIVE |
|  | Temporary Fault. (Usually vehicle related) Press the reset button on the bottom right of the interface to retry charge session | |
|  | Internal Charging Station Error. Discontinue Use | |

# Level 2 DC – Commercial / Fleet

- CHAdeMO protocol
- Output: 50 kW, 400 VDC at 125 ADC
- Can charge a 16kWh battery to 80% capacity in 20 minutes
- Outdoor rated cable
- Compatible with LEAF and i-Miev
- GM and Ford do not have a DC inlet as of yet

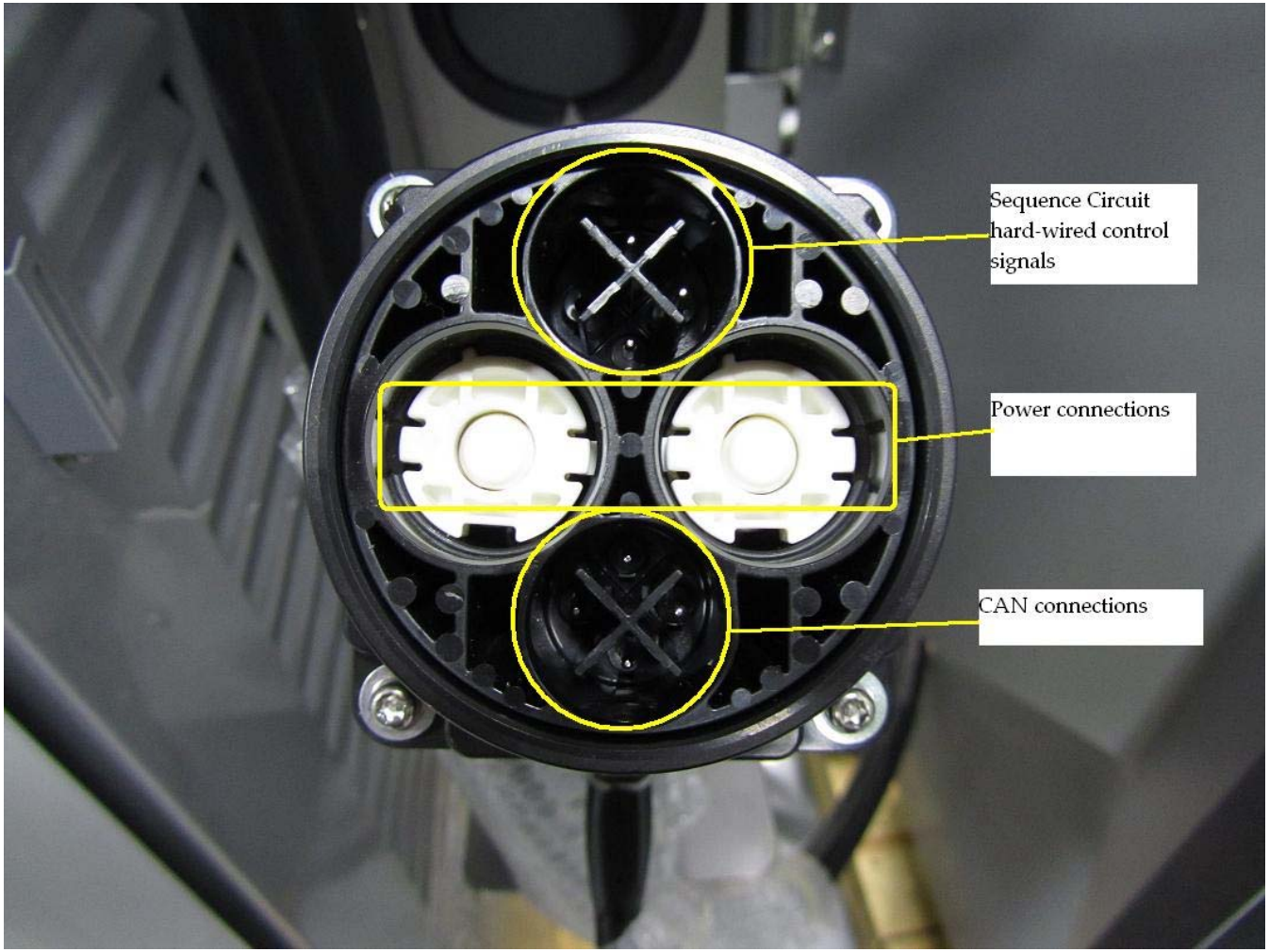
# Power Flow with 208 VAC Input

# Power Requirements
## *Eaton's 50kW DC Quick Charger*



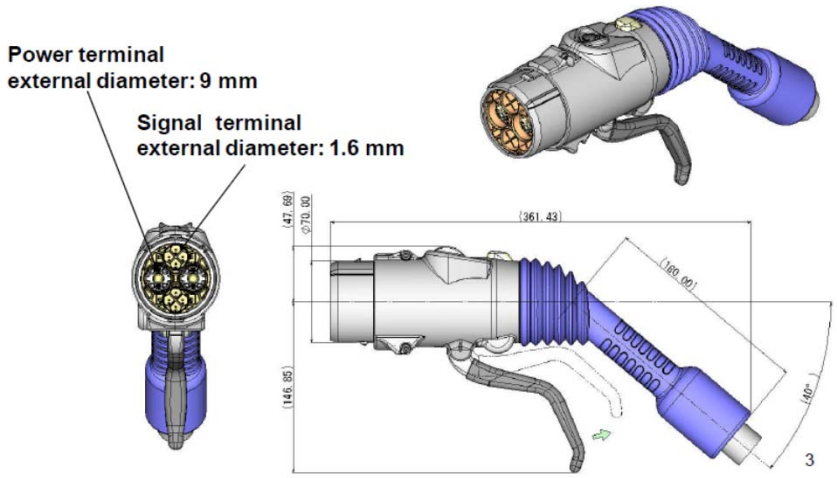

| Voltage 3-phase | Phase Current |
|---|---|
| 198 | 164 |
| 200 | 162 |
| 208 | 156 |
| 480 | 68 |

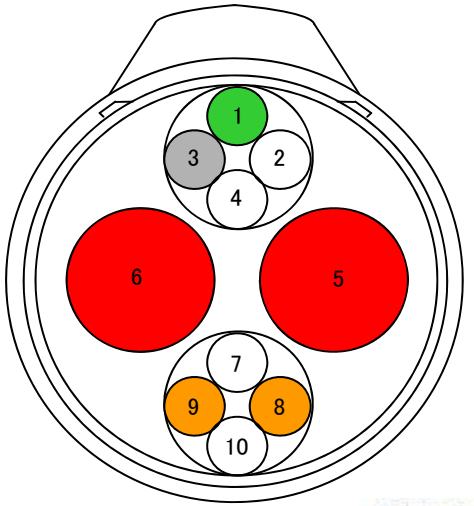
# CHAdeMO Quick DC Charge Connector



# CHAdeMO Overview

- JARI-specified connector and system
- TEPCO-specified communications and system requirements
- 125A and 500V (60kW)
- 10-pin connector
  - 2 power pins
  - 2 communication pins (CAN-bus)
  - 2 charger start/stop pins (EV Contactor Control)
  - 1 proximity detection pin
  - 1 charging enable/disable pin
  - 1 ground reference pin
  - 1 unused pin

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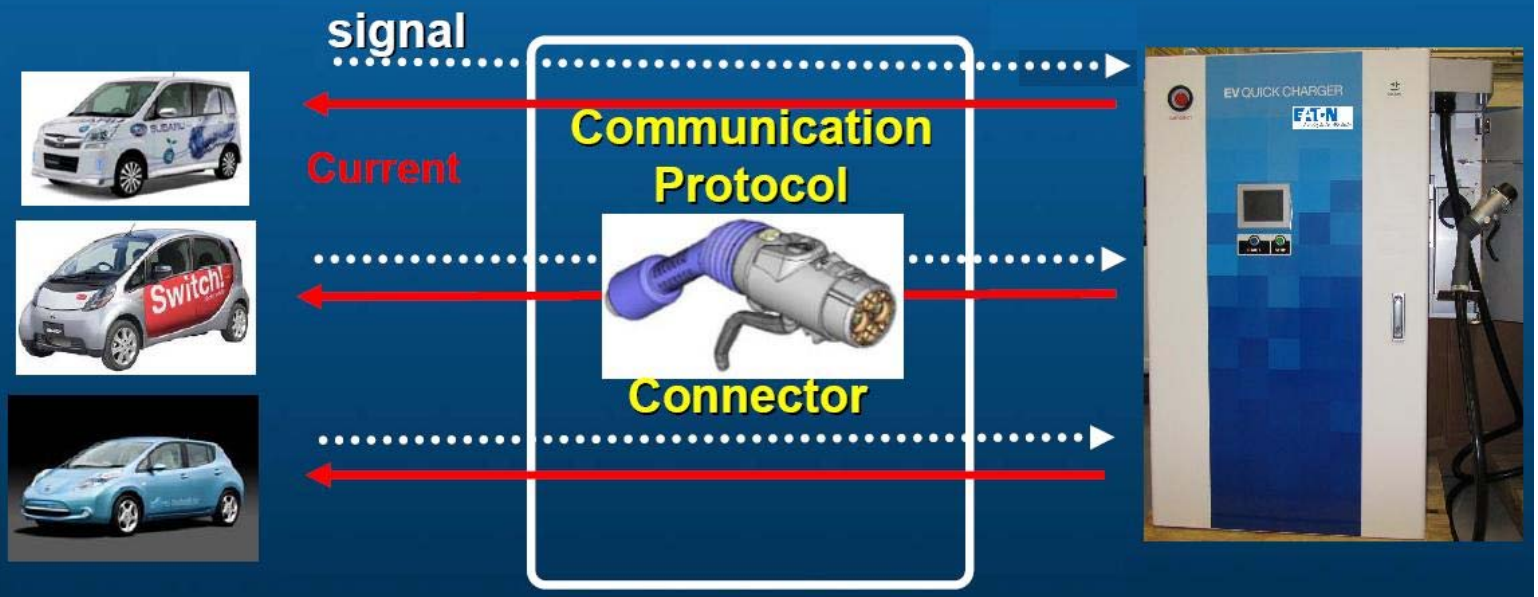
# CHAdeMO Basic Description of DCQC Operation

**How CHAdeMO charger works:**

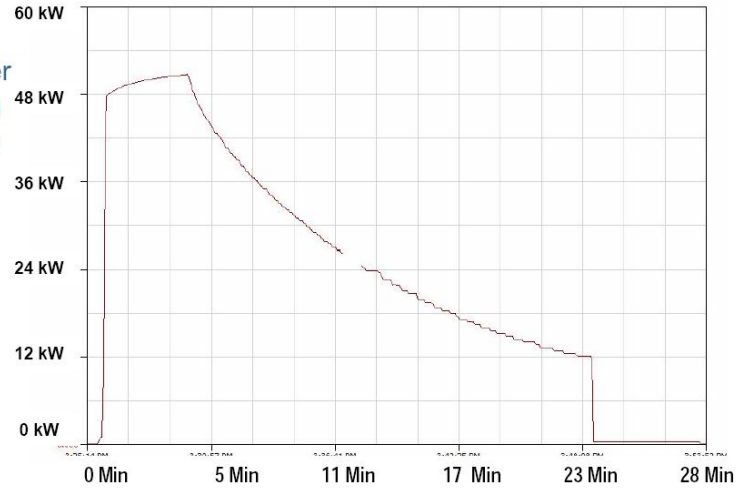
- **EV computer unit decides** charging speed based on BMS observation.
- Charging current signal is sent to charger using CAN bus.
- Charger supplies DC current following the request from EV.



# CHAdeMO is More Than a Connector Specification

- Includes basic electrical safety and structure
- Safety interlock to avoid energizing the connector before it's safe (similar to SAE J1772)
- EV transmits battery parameters to the charging station:
  - voltage at which to stop charging
  - target voltage
  - total battery capacity
  - while charging the station has to vary its output current according to signaling from the car

- 50 kW peak
- Roughly 5 miles per minute of charge in the first 10 minutes of charge
- 6 kWh delivered in the first 10 min; 5 kWH in the remaining 13 minutes

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# Electric Vehicles with CHAdeMO Interfaces


SUBARU Plug-in Stella

Passengers: 4
Weight: 1010kg
Driving range: 90km(10-15 mode)
Battery: 9.2kWh

Protoscar LAMPO2

Passengers: 2
Weight: 1580kg
Driving range: 200km
Battery: 32kWh


Mitsubishi i-MiEV

Passengers: 4
Weight: 1100kg
Driving range: 160km(10-15 mode)
Battery: 16kWh

Peugeot iON

Passengers: 4
Weight: 1100kg
Driving range: 160km(10-15 mode)
Battery: 16kWh

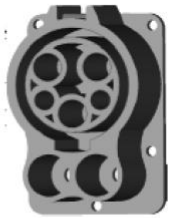
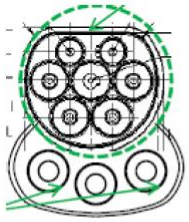
Nissan LEAF

Passengers: 5
Weight: 1520kg
Driving range: 200km(JC08 mode)
Battery: 24kWh

# TEPCO Shows DCQC Connector Proposals at CHAdeMO Meeting

## Main topic of IEC62196-3 and IEC61851-24

**Type of coupler (62196-3)**

| Japan | US | Germany | China |
|---|---|---|---|
| CHAdeMO | COMBO of AC type 1 | COMBO of AC type 2 | DC dedicated |
|  |  |  |  |

**Communication method and protocol (IEC 61851-24)**

| Japan | US/Europe | | China |
|---|---|---|---|
| CAN | PLC | In-band | CAN |

- There are four different proposals of connector shape.
- There are four different proposals of communication protocol, however the U.S. is also considering CAN.
- Only CHAdeMO is available in the market. Other proposals are just design/prototype, not existing.

# EVSE Revenue and Fleet Management



## Wide Variety of Implementation Schemes

Credit Card Processing

Basic RFID – lock & key access

User Authentication with RFID

Synchronous code generation keypad – stored codes, time based codes, pay by phone service

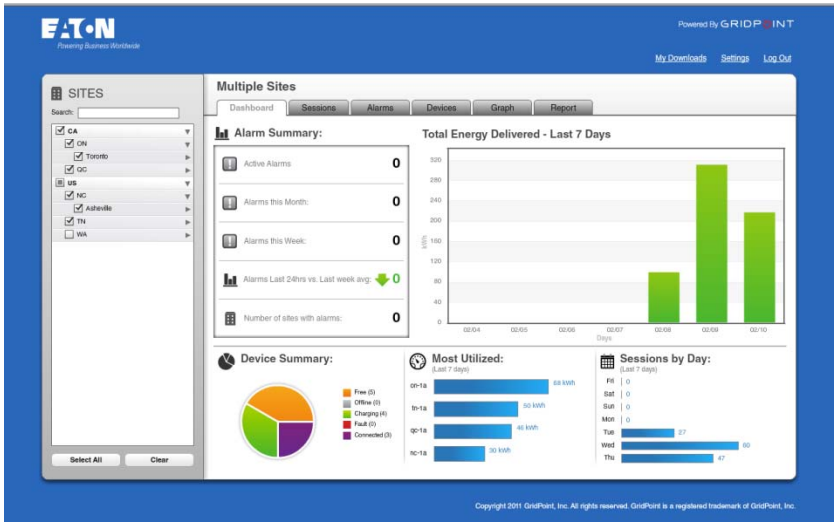
# Pow-R-Station™ Network Manager Software

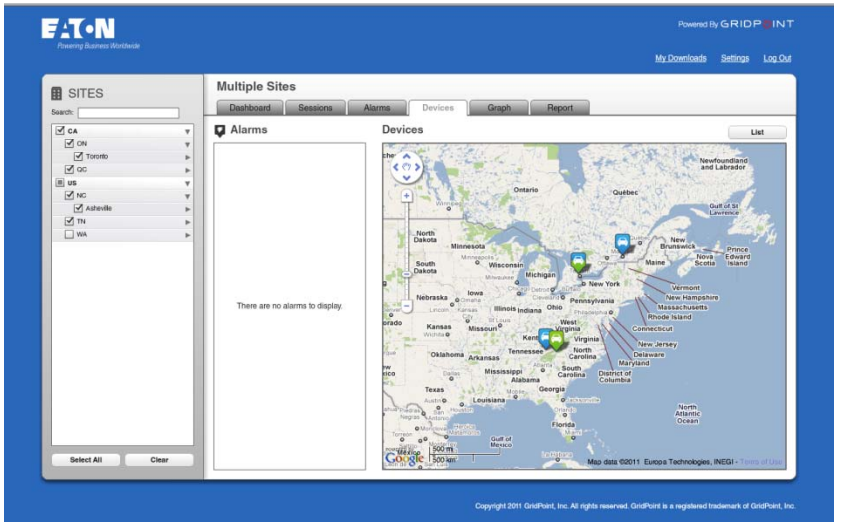
Web Portals for:

- User Authentication
- Fleet, EVSE & Load Management
- Network Provisioning
- Real Time Reporting & Monitoring

Deploy *your* network to:

- Increase System Uptime
- Reduce energy costs
- Maximize charger reliability

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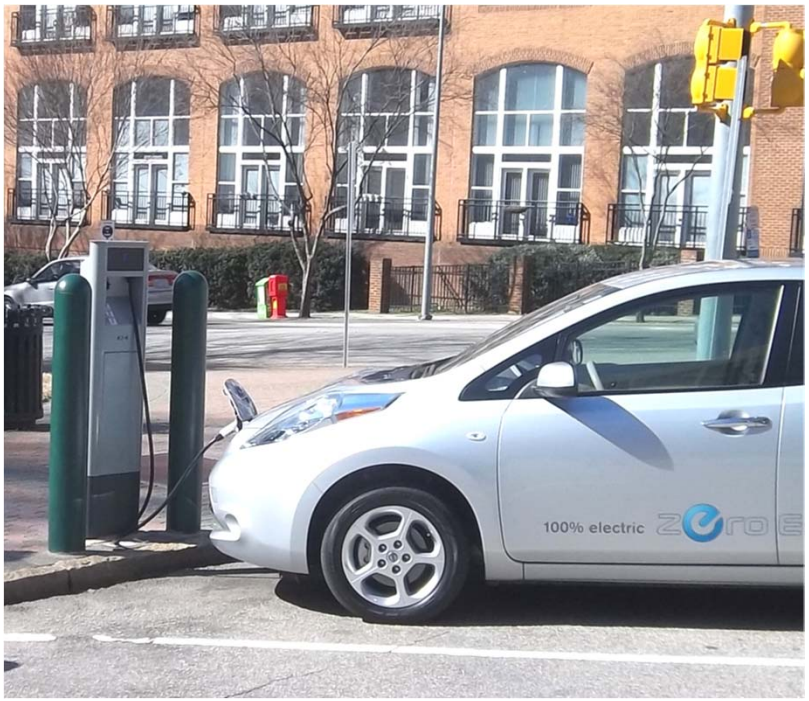


# Questions?

Website

www.eaton.com/plugin


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